Cristilabrum kessneri, a new camaenid land snail from the Jeremiah Hills, Western Australia (Mollusca: Pulmonata: Camaenidae)

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ABSTRACT

Cristilabrum kessneri, new species, is described from a small set of limestone hillocks on the eastern fringe of the Jeremiah Hills. They are situated 6.2 km west of Point Spring, Weaber Ranges and about 42 km north-northeast of Kununurra, Kimberley, Western Australia. *C. kessneri* has the most modified shell of any species belonging to the Ningbing Range-Jeremiah Hills camaenid land snail radiation. Its genitalia also has modifications that correlate with the small size of both the shell and the limestone hillocks on which it lives.

INTRODUCTION

The extraordinary radiation of camaenid land snails that live on the limestone hills of the Ningbing Ranges and Jeremiah Hills in the northeast corner of the Kimberley District, Western Australia have been described (Solem, 1981, 1985, 1988a) and biogeographically analyzed (Solem, 1988b) in a series of reports. Three restricted endemic genera, *Ningbingia* Solem, 1981, *Turgenitubulus* Solem, 1981, and *Cristilabrum* Solem, 1981 have radiated to produce more than 27 endemic species level taxa, all of which have very small species ranges. There is one additional restricted endemic camaenid species, *Ordtrachia elegans* Solem, 1988, that belongs to an East Kimberley-Northern Territory border area genus with four other species (Solem, 1984: 647-670).

Discovery by Vince Kessner of the species described below is clear evidence that the full extent of this radiation remains to be determined. Many small and isolated limestone hills have not been visited by malacologists. It is probable that several more new taxa await discovery and description.

SYSTEMATIC REVIEW

Genus *Cristilabrum* Solem, 1981

The genus *Cristilabrum* has a partly disjunct range, with a few taxa in the Central Ningbing Ranges, several in the South Ningbing Ranges, and then a few species that range southeast through the Jeremiah Hills (Solem, 1988b: 103, maps 15, 25). Eleven described, and one undescribed, species were known previously (Solem, 1981, 1985, 1988a, 1988b: 84, table 4). *Cristilabrum kessneri* extends the generic range only a few hundred metres to the northeast. It occupies the last outlier of exposed limestone before the sandstone masses of the Weaber Ranges.

Cristilabrum kessneri, new species

(Plates 1-2; Figures 1-5)

Comparative remarks

Cristilabrum kessneri, new species, from easternmost outliers of the Jeremiah Hills, is the smallest (mean diameter 12.50 mm) known species of the Ningbing radiation, with a reduced whorl count (Fig. 1, mean 4 5/8+), very low spire (Fig. 2, mean H/D ratio 0.353), wide umbilicus (Fig. 3, mean D/U ratio 4.43), very prominent and partly anastomosing radial sculpture (Figs 1-3) that increases in height upon crossing the protruded peripheral keel (Fig. 2), and the parietal lip, in full adults, is continuous and free of the parietal wall. *Ordtrachia elegans* Solem, 1988, from a larger limestone mass located a few hundred metres to the southwest, is slightly larger (mean diameter 13.20 mm), with a higher whorl count (mean 5 1/8+), elevated spire (Solem, 1988a: 48, fig. 13, mean H/D ratio 0.509), sculpture of prominent pustules (Solem, 1988a: 56, plate 1c-d) rather than radial ribs, and a narrower protruded keel. The only other keeled species in this radiation, *Turgenitubulus pagodula* Solem (1985: 957-959, figs 246d-f, 248a-d), from the Gorge, Central Ningbing Ranges, has the same basic shape, sculpture, and protruded keel, but is much larger (mean diameter 16.83 mm), with more whorls (mean 5 1/8-), higher spire (mean H/D ratio 0.507), much narrower umbilicus (mean D/U ratio 5.78), and the parietal lip is not free of the parietal wall. Species of the sinumelonid genus *Pleuroxia* Ancey, 1887, from the Red Centre, Flinders Ranges, and Nullarbor region are convergent in shape and sculpture, but most species have a microsculpture of dense pustules between the radial ribs and lack the peripheral keel. Anatomically, the long penis, (P, Fig. 4), basal entry of the vas deferens (VD) into the penis sheath (PS), and generalized wall sculpture of the penis chamber (Fig. 5) agree more with the South Ningbing species (Solem, 1981: 400-410, figs 101-105) than with the Jeremiah Hills taxa (Solem, 1981: 411-416, fig. 106; Solem, 1985: 965-975, figs 254-256) or central Ningbing taxa (Solem, 1988a: figs 26-28), which show altered penial structures. *C. kessneri* is most easily distinguished by the proportionate elongation of its albumen gland (GG) and great shortening of the prostate-uterus (DG, UT).

Holotype

Western Australian Museum 654.87, limestone hillocks 6.2 km W of Point Spring, Weaber Range, northeast of Kununurra, Western Australia. 15° 23'

PLATE 1. Shell sculpture of *Cristilabrum kessneri*. 6.2 km W of Point Springs, Weaber Ranges, NE of Kununurra, Western Australia. FMNH 205957: (a) apex and spire at 34.5X; (b) ribs on lower spire at 86X.

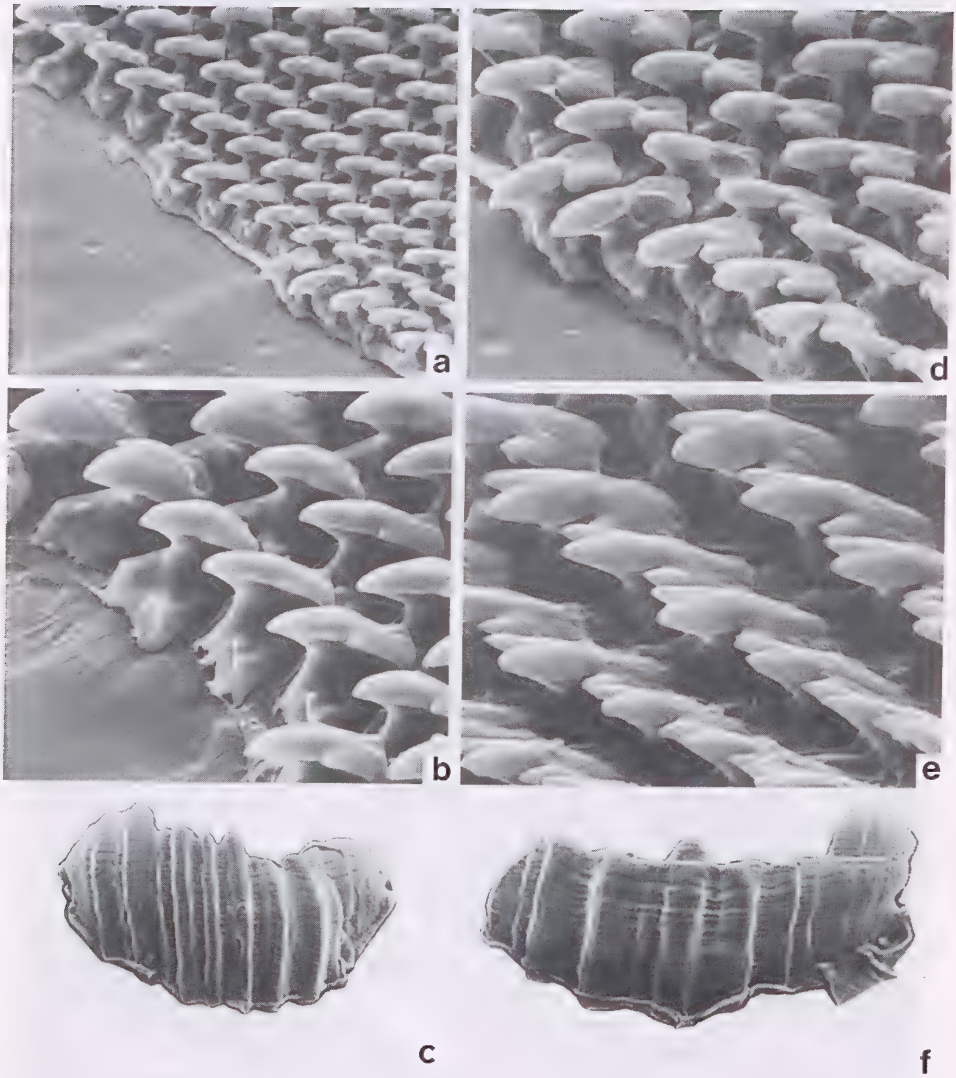


PLATE 2. Radula and jaw of *Cristilabrum kessneri*. 6.2 km W of Point Springs, Weaber Ranges, NE of Kununurra, Western Australia. FMNH 205956: (a) central through lateral field, Dissection A, at 465X; (b) central and first laterals, Dissection B, at 890X; (c) jaw, Dissection B, at 86X; (d) detail of lateromarginal transition, Dissection A, at 940X; (e) mid-marginal teeth, Dissection A, at 1,275X; (f) jaw, Dissection B, at 115X.

44" S, 128° 49' 00" E. Carlton 1:100,00 map sheet 4667-9700:8140. Collected 7 May 1988 by Vince Kessner. Height of shell 4.4 mm, diameter 13.0 mm, H/D ratio 0.338, whorls 4-, umbilical width 2.3 mm, D/U ratio 5.65.

Paratopotypes

WAM 749.87, WAM 750.87, South Australian Museum D18133, Australian Museum C.136037-8, Queensland Museum, Museum of Victoria, Kessner, and Field Museum of Natural History 204956-7, 16 LA, 91 DA, 4 DJ from the type locality. Additional specimens from the type lot have been deposited as Australian Museum C.157458, but were not seen until just before publication and are not considered to be designated type material.

Range

The only set of limestone hillocks from which *Cristilabrum kessneri*, new species, has been collected are located 6.2 km W of Point Spring, Weaber Range, Kimberley, Western Australia, Australia. These hills have a north-south axis of about 400 metres and are less than 50 metres wide. They are the easternmost exposed limestone bits of the Jeremiah Hills.

Diagnosis

Shell very small, adult diameter 10.85-15.1 mm (mean 12.50 mm), with 4 3/8+ to 5 (mean 4 5/8+) normally coiled whorls. Apex and spire (Fig. 2) slightly and evenly elevated, height of shell 3.5-5.35 mm (mean 4.40 mm), H/D ratio 0.283-0.437 (mean 0.353). Apical sculpture (Plate 1a) of vague radial swellings. Spire and body whorl (Figs 1-3, Plate 1a-b) of narrow, prominent, sometimes anastomosing radial ribs with a vague microsculpture of short, crowded microridglets (Plate 1b). Major sculpture not reduced on shell base, and distinctly enlarged where crossing keel. Shell periphery with rounded, protruded keel (Fig. 2). Body whorl descending moderately to sharply just behind aperture. Lip sharply reflected and expanded, continuous across and free of parietal wall, moderately reflected over edge of umbilicus. Basal lip node weak to well developed (Fig. 2), without prominent exterior indentation. Umbilicus open (Fig. 3), partly narrowed by columellar lip, width 2.1-4.5 mm (mean 2.85 mm), D/U ratio 3.26-5.85 (mean 4.43). Shell yellow brown, without darker markings, base lighter in tone, lip white. Based on 107 measured adults.

Genitalia (Figs 4-5) characterized by the long albumen gland (GG), very short prostate-uterus (DG, UT), medium length spermatheca (S), basal entry of the vas deferens (VD) into the penis sheath (PS), elongated and slender penis complex, with penis about equal in length to sheath (Fig. 5), which has a moderately thickened wall. Interior of penis with two rounded longitudinal pilasters basally, one extending subapically into area of small, complex pilasters (Fig. 5). Penial retractor muscle (PR) long, entering sheath at apex, descending free to insert on the vas deferens-penis junction.

Central and early lateral teeth of radula (Plate 2a-b) with small anterior flare, short basal plates, slightly elevated cusp shaft, cusp tip blunt and slightly curved, ectocone weak on central and 1st lateral, prominent on other laterals. Laterals about 10 (Plate 2a), anterior flare and ectocone enlarged on later

teeth, lateromarginal transition (Plate 2b) rapid. Midmarginal teeth (Plate 2e) with large endocone that sometimes becomes bifurcated. Jaw (Plate 2c, f) highly variable in ribbing, with width and frequency depending upon repaired injuries.

Discussion

The type collection of *Cristilabrum kessneri* contained 16 live and 91 dead adult examples. Measurements of these two samples showed that, with one exception, the differences between the means of each parameter were less than the combined standard errors of the mean, and thus not significantly different. Shell height of the live examples was 0.194 mm greater than the dead examples, while the combined SEM's of the two samples was only 0.133, suggesting at most very little difference.

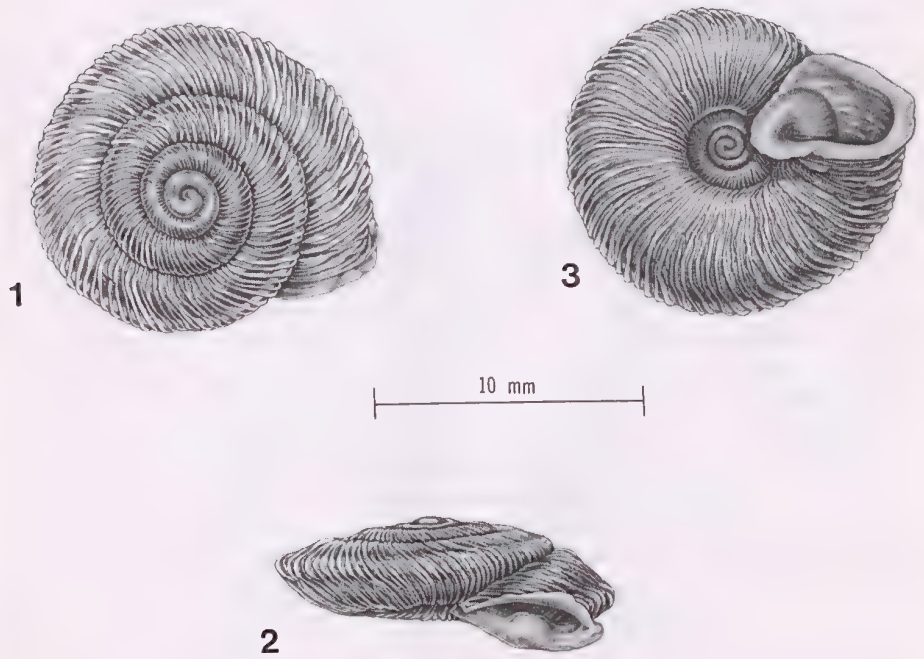
At first glance, the shell (Figs 1-3) appears to be very different from all other *Cristilabrum*. The very high, anastomosing radial sculpture, protruded keel, wide umbilicus, and free parietal lip are not duplicated elsewhere in the genus. While species such as *C. buryillum, C. primum, C. grossum, C. bubulum* and *C. bilarnium* (Solem, 1981: plts 17-18); *C. spectaculum* and *C. isolatum* (Solem, 1985: 966-975) do have prominent low, rounded radial ribs on the shell, in all but *C. primum* these ribs are absent from or reduced on the shell base. These ribs do not anastomose and are very different in structure from the high ribs of *C. kessneri.*

C. kessneri also differs considerably from the other species of *Cristilabrum* in size and shape. The mean diameter of other *Cristilabrum* species (Table 2) ranges between 16.75 and 20.72 mm (12.50 mm in *C. kessneri*); mean whorl count 4 ⅞+ to 5 ⅞+ (only 4 ⅝+ in*C. kessneri*); mean H/D ratio 0.482-0.613 (only 0.353in *kessneri*); mean D/U ratios 5.95-10.8 (4.43 in *kessneri*). *C. kessneri* is small, with a reduced whorl count, much lower H/D ratio, and wider umbilicus than any other member of the genus. The nearest whorl count is that of *C. primum* (mean 4 ⅞+), which is noticably reduced from the next lowest (5 ¼ in *C. buryillum*), while the relatively widely open umbilicus of *C. isolatum* Solem (1985: 967, fig. 253f, mean 5.98) results from the narrow lip reflection. The widths of the two umbilici thus are not directly comparable, since the degree of lip narrowing is very different.

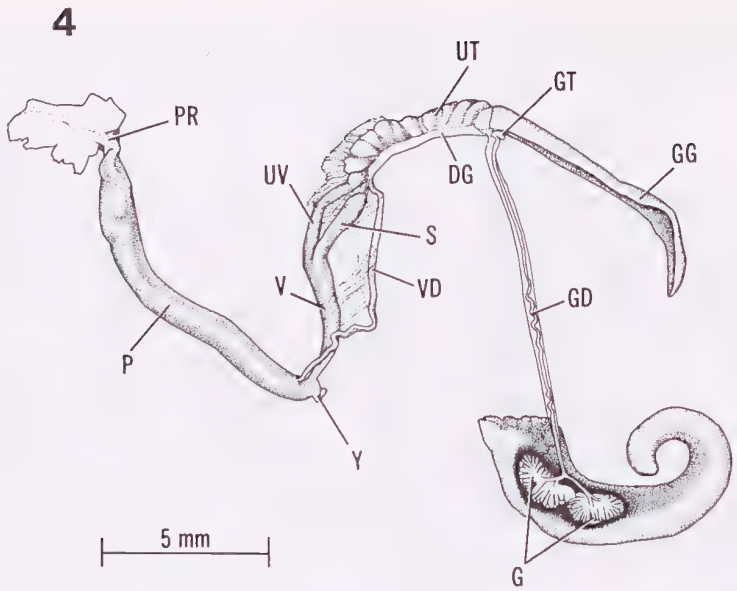
Can these differences be correlated with any habitat data? Probably the shell size difference of *C. kessneri* relates to the very small size of the limestone hills on which it lives. These hills are much lower and smaller than those inhabited by *C. isolatum*, for example, and thus would dry out more quickly. The more limited activity time available because of this fact would tend to cause shell growth to stop at a lower whorl count. Narrow inner portions of the very deep crevices would retain moisture longer, and hence the depressed shape, which caused the low H/D ratio, could result in added activity time. The wider umbilicus is a normal concomitant of the low spire. Thus the shell size and shape changes in *C. kessneri* probably result from simple moisture factors. The significance of the strong shell surface sculpture is unknown.

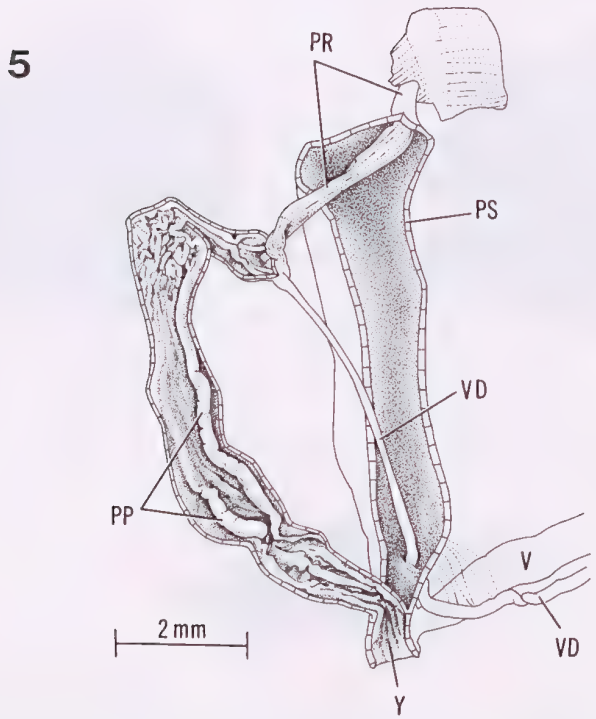
TABLE 1. Length of Genital Organs in *Cristilabrum* species

Species	Length in mm of:- Penis complex	Albumen gland	Prostate-uterus	Sperm-theca	Vagina	PS/P ratio
C. solitudum	9.5	14	14.5	5	4	1.2
C. rectum	5	15	13	6	4	1.0
C. n. sp.	10	11	11	2	5	1.5
C. buryillum	12	9	9	3	7	2.0
C. simplex	12.5	12.5	12.5	4.7	10	3.0
C. monodon	12.5	11.5	11	3	8.5	1.3
C. primum	12	10.5	12.5	3	8	2.0
C. grossum	16	10	10.5	2.5	8	2.5
C. bubulum	13	10	12	2.75	7	1.25
C. isolatum	10	13	12	2.5	4	2.0
C. spectaculum	13	12.5	14	4	4	1.0
C. bilarnium	3	10.5	13	1.5	2	1.0
C. kessneri	12	8.5	5	2	4	1.25



FIGURES 1-3. Holotype of *Cristilabrum kessneri*: small limestone hillocks 6.2 km W of Point Spring, Weaber Ranges, NE of Kununurra, Western Australia, Australia. WAM 654.87. Scale line equals 10 mm.





FIGURES 4-5. Genitalia of *Cristilabrum kessneri*. FMNH 205956. small limestone hillocks 6.2 km W of Point Spring, Weaber Ranges, NE of Kununurra, Western Australia. 7 May 1988: 4, whole genitalia, Dissection A: 5, interior of penis complex, Dissection B. Scale lines as marked.

Anatomical differences also can be correlated with the change in size and whorl count. Table 1 lists the approximate length in mm for different genital organs in fully adult examples of the 13 currently recognized taxa of *Cristilabrum*. Two factors make it very difficult to get accurate length measurements of the genitalia: 1) several organs are coiled within the visceral hump inside the shell - rarely can they be fully straightened for measurement; and 2) unless the animal died in a fully extended position, the anterior genital organs will be "folded-contracted-squeezed-displaced" by the partial retraction of the head and neck of the animal distorting the shape and altering the size of these organs. The additional problems of maturation changes and seasonality differences, as outlined by Solem & Christensen (1984), have been avoided by use of only fully mature examples for these measurements.

The species are listed in roughly northwest to southeast order in Table 1, with actual contiguity of taxa at times replacing strict geographic order. There are few general trends evident, and some special situations. The two species with short penis complexes, *C. rectum* and *C. bilarnium,* have the penis transitional to *Turgenitubulus*, whereas the length of the penis complex otherwise varies only moderately, despite the differences in shell size; short vaginae (2-5 mm long) are found at the northern and southern ends of the genus range, with longer (7-10 mm) vaginae in the centrally located species; spermathecal length is quite variable and without a clear pattern; the higher penis sheath/penis length (PS/P) ratios (2-3) are found in species that live on larger limestone masses (*buryillum*, *simplex*, *primum*, *grossum*) or are derived from one of these species (*isolatum* is closely related to *grossum*), while species that live on a corner of or smaller hills immediately adjacent to the same large masses (*monodon*, *bubulum*) have lower ratios (1.25-1.3); and the lengths of the albumen gland and prostate-uterus are fairly close to each other within all species except *C. kessneri.*

The above data will be discussed in more detail elsewhere, but are necessary background to understanding the differences found in *C. kessneri.* Table 2 gives the mean diameter and whorl count for each species, and then contrasts the mean of all other species with the size of *C. kessneri.* This serves to emphasize the fact that the latter is not only smaller in diameter, but has a much lower whorl count than other *Cristilabrum.* The latter change has two effects: 1) there is less *spiral* distance from the shell aperture to apex of the shell, and hence the genitalia has to be shortened; and 2) the whorl cross-sectional area is reduced for each portion of the genitalia, resulting in slenderization of organs. Compensation for these shifting parameters could have been accomplished by either: 1) overall and proportional length and cross sectional area decrease in most organs; and 2) "zonal compaction" with the decrease limited to one or two portions of the genital system.

Strong evidence for the latter change is seen in Table 1 and Fig. 4. In *C. kessneri* the penis complex and vagina have not been shortened in an absolute sense, whereas the length of the prostate-uterus (5 mm) is both proportionately and absolutely reduced in length. The albumen gland is a little shorter, but remains proportionately long. All of the latter organs are slender in

comparison with equivalent structures in the other species of *Cristilabrum*. Thus "zonal compaction", rather than "proportional shortening", has occurred.

C. kessneri is the only member of the restricted endemic camaenid radiation present at the only known locality. Thus no "species recognition" modifications of the terminal genitalia were either expected or found. Some recently dead and many long dead but no living examples, of *Torresitrachia weaberana* Solem, 1979 were collected by Vince Kessner (AM C.157456-7). They are noticably larger (mean diameter 17.2 mm) than Point Spring, Weaber Range examples (see Solem, 1979, tables 5, 7) that inhabit sandstone cliffs rather than limestone. The fact that whorl count is the same, despite the size increase, suggests a thicker shell in the limestone rich environment. While this station is "quality" for the weed-like *T. weaberana*, which often is found under fringe conditions, and thus size has increased, it is "less than ideal" for the *Cristilabrum* that inhabits the larger limestone masses to the west and northwest.

The anatomical change outlined above with zonal compaction instead of proportional change, is solid evidence that the small size and low whorl count of *C. kessneri* are secondary features. If it was primitively small, with other *Cristilabrum* species derived from *C. kessneri*, then the genitalia of the latter should show more general features.

C. kessneri is a specialized species, whose unusual structures correlate with the small size, and thus reduced moisture retaining potential, of its habitat.

TABLE 2. Mean Diameters and Whorl Counts of *Cristilabrum* species

Species	Mean Shell Diameter in mm	Mean Whorl Count
C. solitudum	17.96	5.59
C. rectum	19.22	5.91
C. new species	17.65	5.59
C. buryillum	16.75	5.34
C. simplex	18.60	5.42
C. monodon	17.37	5.49
C. primum	17.29	4.94
C. grossum	20.72	5.32
C. bubulum	17.68	5.51
C. isolatum	19.75	5.59
C. spectaculum	20.59	5.73
C. bilarnium	18.93	5.80
Mean and range of means	18.54 (16.75-20.72)	5.52 (4.94-5.91)
C. kessneri	12.50	4.65

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LITERATURED CITED

Solem, A. 1979. Camaenid Land Snails from Western and central Australia (Mollusca: Pulmonata: Camenidae). I. Taxa with trans-Australian distribution. Rec. Western Aust. Mus., Suppl. 10: 1-142, figs 1-35, plts 1-11, tables 1-10.

Solem, A. 1981. Camaenid Land Snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae). III. Taxa from the Ningbing Ranges and Nearby Areas. Rec. Western Aust. Mus., Suppl. 11: 321-425, figs 74-110, plts 15-18, tables 34-42.

Solem, A. 1984. Camaenid Land Snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae). IV. Taxa from the Kimberley, *Westraltrachia* Iredale, 1933 and related genera. Rec. Western Aust. Mus., Suppl. 17: 426-706, figs 111-180, plts 19-63, tables 43-75.

Solem, A. 1985. Camaenid Land Snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae). V. Remaining Kimberley Taxa and Addenda to the Kimberley. Rec. Western Aust. Mus., Suppl. 20: 707-981, figs 181-256, plts 64-94, tables 76-94.

Solem, A. 1988a. New camaenid land snails from the northeast Kimberley, Western Australia. J. Malac. Soc. Aust. 9: 27-58, figs 1 - 34, plates 1-3.

Solem, A. 1988b. Maximum in the minimum: Biogeography of land snails from the Ningbing Ranges and Jeremiah Hills, northeast Kimberley, Western Australia. J. Malac. Soc. Aust. 9: 59-113, tables 1-10, maps 1-23.

Solem, A. & Christensen, C.C. 1984. Camaenid land snail reproductive cycle and growth patterns in semi-arid areas of northwestern Australia. Austr. J. Zool. 32 (4): 471-491, figs 1-2, tables 1-5.